The methodology proposed by Martins et al. [2], containing 3D-indicators, has been updated, modified and extended including the concept of time, related to discontinuous processes as pharmaceutical ones. The methodology takes into account E-factor proposed by Shield et al. [3], Energy Intensity (EI), Potential Chemical Risk (PCR) and Potential Environmental Impact (PEI) modified by considering the cycle of batch reactors and H-Phases. The 3D-indicators are calculated using the results obtained from previous work [2] and it is possible to apply a database containing data from DRA, other sources, and an in-house procedure for the estimation of toxico-logical properties based on molecular modeling. One dimensional indicators are focused on single contribution to sustainability, e.g. Waste Reduction Algorithm (WRA) [4] focused on environmental issues, Profit Intensity, an index based on Materials Intensity [2] and modified to inspect economic aspects, and HTP (Hazard Toxicity Potential) developed to define the hazard risks for employers inside the chemical plant.

### 3D - Indicators

Three dimensional evaluation provides an overview of sustainability performance of process design under study, taking into account all contribution to sustainability at once.

E-Factor

E-factor evaluates the yield of the process in terms of raw materials consumption.

### Energy Intensity (EI)

Energy Intensity takes into account the performance from an energetic point of view focusing on non-renewable sources consumption.

### Potential Chemical Risk (PCR)

Potential Chemical Risk [Vincent et al. [5]] enables the human health risk related to hazardous chemicals inside the industrial plant. Each chemical is assigned to a series of hazards, depending on frequencies of usage, quantity adopted and hazard related to each chemical. The final value is the result of the sum of PCR specific for each substance.

### Potential Environmental Impact (PEI)

Potential Environmental Impact [5] inspects the environmental issues due to polluting chemicals. The procedure to calculate the final score is the same as the one adopted for PCR evaluation, following a series of assignments to classes for each chemical within the process. Physical state of substances has to be defined to address the impact on different medium.

### Profit Intensity (PI)

Profit intensity provides an estimation on economic aspects of sustainability in order to get a hint about the profit related to process alternatives. The mass of each chemical involved in inlet and outlet streams and the price of the relative substance is compulsory for the calculation.

### References


